DOCUMENT RESUME

ED 430 537 IR 019 566

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TITLE	The Impact of Education Technology on Student Achievement: What the Most Current Research Has To Say.
INSTITUTION	Milken Exchange on Education Technology, Santa Monica, CA.
PUB DATE	1999-00-00
NOTE	13p.
AVAILABLE FROM	Milken Exchange on Education Technology, Milken Family Foundation, 1250 Fourth St., Fourth Floor, Santa Monica, CA 90401-1353; Tel: 310-998-2825; Fax: 310-998-2899; Web site: www.milkenexchange.org
PUB TYPE	Information Analyses (070) -- Reports - Evaluative (142)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Achievement; *Computer Assisted Instruction; *Educational Research; *Educational Technology; Elementary Secondary Education; *Instructional Effectiveness; Literature Reviews; Meta Analysis; Partnerships in Education; Use Studies
IDENTIFIERS	Apple Classrooms of Tomorrow; *Impact Evaluation; Learning Environments; *Technology Utilization; West Virginia

ABSTRACT

This document analyzes the following five large-scale studies of education technology: (1) "Meta-Analytic Studies of Findings on Computer-Based Instruction" (J.A. Kulik) employed a statistical technique called meta-analysis to aggregate the results of over 500 individual studies to draw a single conclusion; (2) "Report on the Effectiveness of Technology in Schools, 1990-1997" (J. Sivin-Kachala) reviewed hundreds of individual studies whereby the authors shed light on consistent patterns that emerged across studies; (3) "Evaluating the Apple Classrooms of Tomorrow" (E.L. Baker, M. Gearhart, & J.L. Herman) reviewed a partnership between Apple and five schools across the nation; (4) "West Virginia's Basic Skills/Computer Education Program: An Analysis of Student Achievement" (D. Mann, et al.) reported the results of West Virginia's 10-year statewide education technology initiative; and (5) "Does It Compute? The Relationship between Educational Technology and Student Achievement in Mathematics" (H. Wenglinsky) assessed a national sample of fourth- and eighth-grade students using newer simulation and higher order thinking technologies. An evaluation of two smaller-scale studies that point to the promise that newer technologies currently afford is also included: "Computer Support for Knowledge-Building Communities" (M. Scardamalia & C. Bereiter) and "Software Design as a Learning Environment" (I. Harel & S. Papert). Conclusions are summarized related to impact and effectiveness. (AEF)

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ED 430 537

The Impact of Education Technology on Student Achievement

What the Most Current Research Has to Say

by John Schacter

Milken EXCHANGE on education technology

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The author would like to thank Tom Boysen, Cheryl Fagnano, and Michael Reese for their valuable suggestions and contributions received on early iterations of this briefing.

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The Impact of Education Technology on Student Achievement:

What the Most Current Research Has to Say

Legislators, governors and other policymakers each year make difficult choices among attractive educational improvement options. Whether they invest in class size reduction, teacher training, early childhood education, or textbooks and tests turns on their estimate of the effectiveness of these approaches.

The purpose of this briefing is to outline what we know about the impact of education technology on learning and to identify resources for further study.

Research on the impact of technology on learning is in its infancy though we are beginning to see solid work emerge. In this report we look at some large scale state and national studies as well as some innovative smaller studies that provide visions for new uses of technology in learning and instruction.

Research on Education Technology's Impact

Below we analyze the 5 largest scale studies of education technology to date. These studies were selected for their scope, comprehensive samples, and generalizability to local, state, and national audiences. We also include an evaluation of two smaller scale studies that point to the promise that newer technologies currently afford.

The first study we analyze employed a statistical technique called meta-analysis to aggregate the results of over 500 individual studies to draw a single conclusion. The second reviewed hundreds of individual studies whereby the authors shed light on consistent patterns that emerged across studies. The third reviewed a partnership between Apple and five schools across the nation. The fourth study reported the results of West Virginia's 10 year statewide education technology initiative. The fifth assessed a national sample of fourth- and eighth-grade students using newer simulation and higher order thinking technologies. The sixth and seventh reviewed two smaller scale studies that show the promise of newer emerging technologies on student learning.

The intent of this document is to briefly summarize the positive and negative impact of various technology studies on student achievement. More in depth information about several of the studies reviewed within this briefing can be found by accessing this report at the Milken Exchange Web site (www.milkenexchange.org).

1. Kulik's Meta-Analysis Study

James Kulik (1994) used a research technique called meta-analysis to aggregate the findings from more than 500 individual research studies of computer-based instruction. Computer-based instruction individualizes the educational process to accommodate the needs, interests, proclivities, current knowledge, and learning styles of the student. Computer-based instruction software consists of tutorial, drill and practice, and more recently Integrated Learning Systems. Kulik drew several conclusions from his 1994 work:

Positive Findings

- On average, students who used computer-based instruction scored at the 64th percentile on tests of achievement compared to students in the control conditions without computers who scored at the 50th percentile.
- Students learn more in less time when they receive computer-based instruction.
- Students like their classes more and develop more positive attitudes when their classes include computer-based instruction.

Negative Findings

- Computers did not have positive effects in every area in which they were studied.

Meta-Analysis	Instructional Level	Number of Studies Analyzed	Percentile Gain over Control Group
Bangert-Drowns, J. Kulik, & C. Kulik (1985)	Secondary	51	10
Burns & Bozeman (1981)	Elementary & Secondary School	44	14
Cohen & Dacanay (1991)	Health Professions Education	38	18
Hartley (1978)	Elementary & Secondary Math	33	16
Fletcher (1990)	Higher Education & Adult Training	28	19
C. Kulik & J. Kulik (1986)	College	119	11
C. Kulik, J. Kulik, & Shwalb (1986)	Adult Education	30	15
J. Kulik, C. Kulik, & Bangert-Drowns (1985)	Elementary	44	16
Niemiec & Walbert (1985)	Elementary	48	14
Roblyer (1988)	Elementary to Adult Education	82	12
Schmidt, Weinstein, Niemiec, & Walberg (1985)	Special Education	18	22
Willett, Yamashita, & Anderson (1983)	Pre-College Science	11	9

Note: Table excerpted from Kulik, James A. (1994). Meta-Analytic Studies of Findings on Computer-Based Instruction.

2. Sivin-Kachala's Review of the Research

Jay Sivin-Kachala (1998) reviewed 219 research studies from 1990 to 1997 to assess the effect of technology on learning and achievement across all learning domains and all ages of learners. From his analysis of these individual studies he reported the following consistent patterns:

Positive Findings

- Students in technology rich environments experienced positive effects on achievement in all major subject areas.
- Students in technology rich environments showed increased achievement in preschool through higher education for both regular and special needs children.
- Students' attitudes toward learning and their own self-concept improved consistently when computers were used for instruction.

Inconclusive Findings

- The level of effectiveness of educational technology is influenced by the specific student population, the software design, the educator's role, and the level of student access to the technology.

3. The Apple Classrooms of Tomorrow (ACOT)

In their evaluation of the Apple Classrooms of Tomorrow, Baker, Gearhart, and Herman (1994) assessed the impact of interactive technologies on teaching and learning in five school sites across the nation (e.g., California, Tennessee, Minnesota, and Ohio). The goals of ACOT were to encourage instructional innovation, and to emphasize to teachers the potential of computers to support student initiative, long-term projects, access to multiple resources, and cooperative learning. Over the course of the five year initiative, comparisons were made of a) ACOT students' basic skills performance to nationally reported norms, b) ACOT students' progress and achievement over time, and c) ACOT teachers' teaching practices.

Positive Findings

- The ACOT experience appeared to result in new learning experiences requiring higher level reasoning and problem solving, although the authors claim this finding was not conclusive.
- ACOT did have a positive impact on student attitudes and did have an impact on changing teacher teaching practices toward more cooperative group work and less teacher stand-up lecturing.

Negative Findings

- On standardized tests including vocabulary, reading comprehension, mathematics concepts, and work-study, ACOT students performed no better than comparison groups or nationally reported norms who did not have access to computers or to the teaching and learning reforms implemented in ACOT schools.

4. West Virginia's Basic Skills/Computer Education (BS/CE) Statewide Initiative

Dale Mann's (1999) study of the state of West Virginia's Basic Skills/Computer Education (BS/CE) program analyzed a representative sample of 950 fifth-grade students' achievement from 18 elementary schools across the state. These fifth-grade students had been participating in the West Virginia BS/CE program since 1991-92. Data was also collected from 290 teachers to show the influence that West Virginia's Integrated Learning System technology had on student achievement. The Integrated Learning System technology focused its teaching on spelling, vocabulary, reading and mathematics. Several variables were collected and analyzed i.e., intensitivity of Basic Skills/ Computer Education (BS/CE), student prior achievement and sociodemography, teacher training, teacher and student attitudes toward BS/CE. The findings for West Virginia's statewide initiative were as follows:

Positive Findings

- The more students participated in BS/CE, the more their test scores rose on the Stanford 9.
- Consistent student access to the technology, positive attitudes towards the technology (by both teachers and students), and teacher training in the technology led to the greatest student achievement gains. All students' test scores rose on the Stanford 9 because of BS/CE with lower achieving student scores rising the most.
- Half of the teachers in the sample thought that technology had helped a lot with West Virginia's instructional goals and objectives. These teachers also reported that they became more enthusiastic about BS/CE as time passed.
- Although the relative disadvantage of girls is a regularity of the technology literature, girls and boys did not differ in achievement, access, or use of computers in the West Virginia study.

Lewis Solmon's (1999) cost benefit analysis of the West Virginia Basic Skills/Computer Education program compared the cost of BS/CE and its achievement gains to the cost of other reform programs and their achievement gains. Solmon demonstrated that:

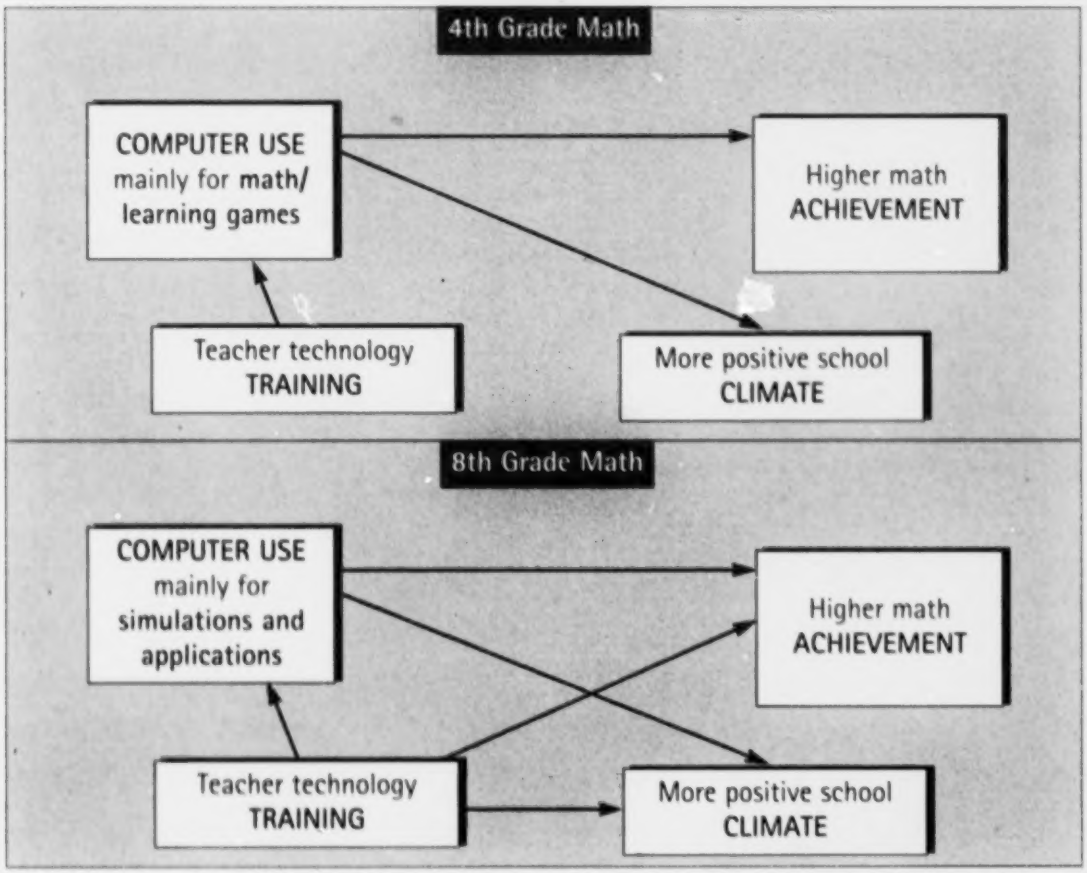
- BS/CE was more cost effective in improving student achievement than (1) class size reduction from 35 to 20 students, (2) increasing instructional time, and (3) cross age tutoring programs.

5. Harold Wenglinsky's National Study of Technology's Impact on Mathematics Achievement

Harold Wenglinsky (1998) assessed the effects of simulation and higher order thinking technologies on a national sample of 6,227 fourth graders and 7,146 eighth graders mathematics achievement on the National Assessment of Educational Progress. Wenglinsky controlled for socioeconomic status, class size, and teacher characteristics. Thus, all relationships between technology and educational outcomes reported represent the value added by technology for comparable groups of students with comparable teachers in comparable class sizes. Wenglinsky found:

Positive Findings

- Eighth-grade students who used simulation and higher order thinking software showed gains in math scores of up to 15 weeks above grade level as measured by NAEP.
- Eighth-grade students whose teachers received professional development on computers showed gains in math scores of up to 13 weeks above grade level.
- Higher order uses of computers and professional development were positively related to students' academic achievement in mathematics for both fourth- and eighth-grade students.


4th Grade Math
COMPUTER USE mainly for math/ learning games
Higher math ACHIEVEMENT
Teacher technology TRAINING
More positive school CLIMATE
8th Grade Math
COMPUTER USE mainly for simulations and applications
Higher math ACHIEVEMENT
Teacher technology TRAINING
More positive school CLIMATE

SOURCE: Educational Testing Service, "Does it compute?" an analysis of 1996 National Assessment of Educational Progress.

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Negative Findings

- Fourth-grade students who used technology to play learning games and develop higher order thinking performed only 3 to 5 weeks ahead of students who did not use technology.

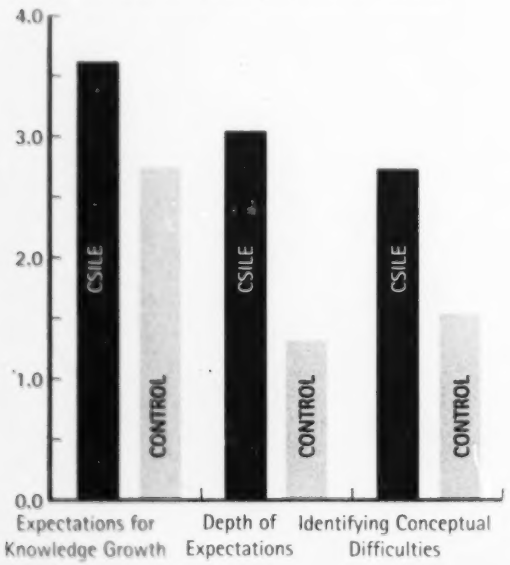
- Both fourth- and eighth-grade students who used drill and practice technologies performed worse on NAEP than students who did not use drill and practice technology.

6. Scardamalia & Bereiter's Computer Supported Intentional Learning Environment (CSILE) Studies

Recent advances in networked technologies are making working on a computer a social and collaborative enterprise. Marlene Scardamalia and Carl Bereiter's (1996) Computer Supported Intentional Learning Environment (CSILE), the most widely studied collaborative computer application in schools today, had entire classrooms of children conceive, respond to, and reframe what is said and written over time on computers. CSILE students ask questions, search for other students' answers to their questions, comment on and review other students' work, and then restructure and formulate answers to their original inquiries. Eight years of research on CSILE has demonstrated that:

- CSILE students surpass students in control classrooms on measures of depth of understanding, reflection, and also on standardized reading, language, and vocabulary tests.

- CSILE maximizes student reflection and encourages progressive thought, taking multiple perspectives, and independent thinking.



Source: Scardamalia, M., & Bereiter, C.: CSILE Learning Gains (1996)

7. The Learning and Epistemology Group at MIT

Seymour Papert, Mitchel Resnick, Yasmin Kafai, and Idit Harel have employed learning by design principles to educational technology by having students become creators and designers of educational software. These researchers use the computer as the machine to be acted upon and students as the actors. Thus, children learn through design activities by programming computers to create applications that other children use and learn from.

Research by Idit Harel (1988; 1991) introduced Logo programming to design software to teach fractions to younger students. Students had to structure their computer program, maintain connections between content and functionality, and design the user interface and activities. In addition, students needed to consider different ideas about how to teach fractions to younger students. Harel's research demonstrated that:

- Students who designed fraction software for other students using Logo learned fractions better than students taught fractions using conventional methods.

- Students who used Logo to design software learned Logo better than students who received Logo programming instruction only.

Conclusion on Impact and Effectiveness

These studies show that in over 700 empirical research studies, in the study of the entire state of West Virginia, in a national sample of fourth- and eighth-grade students, and in an analysis of newer educational technologies that students with access to

(a) computer assisted instruction, or

(b) integrated learning systems technology, or

(c) simulations and software that teaches higher order thinking, or

(d) collaborative networked technologies, or

(e) design and programming technologies,

show positive gains in achievement on researcher constructed tests, standardized tests, and national tests.

There is, however, evidence in some of these studies that learning technology is less effective or ineffective when the learning objectives are unclear and the focus of the technology use is diffuse.

"One of the enduring difficulties about technology and education," according to Dr. Martha Stone Wiske, co-director of the Educational Technology Center at the Harvard Graduate School of Education, "is that a lot of people think about the technology first and the education later."

To assist educators and policymakers in putting education first, the Milken Exchange serves as a clearinghouse of research and information on learning technology. To facilitate policy development and planning, the Exchange has developed its *Seven Dimensions of Learning Technology*. By paying attention to the learner, the learning environment, professional competency, system capacity, community connections, technology capacity, and accountability, technology will be kept in service to learning.

For more information on the Milken Exchange visit our Web site at www.milkenexchange.org. For a more detailed account of this article see John Schacter's publication "Does Technology Improve Student Learning and Achievement? How, When, and Under What Conditions?" in volume 20, 1999 of the *Journal of Educational Computing Research*.

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